

those shown in Fig. 3. Similar results are shown for the Vyrnwy type dam.

As a result of the first set of tests, the authors maintain that, allowing for all irregularity in measurement and material, there is no approach to linearity of normal stress up at least two-thirds, and probably up the whole height of dams of current form. The mid-third rule is, therefore, considered valueless as a stability test, and the success of engineers in building stable dams is attributed more to experience in choice of contours, and in the use of a large factor of safety than to any validity in the method of design. The complexity of the problem and the variations of shear distribution led the authors to make a second series of experiments, using many experimental refinements. The general results were of the same character, and an interesting set of curves is presented showing the actual stresses in the Assuan dam as calculated from the more refined measurements on the model. These curves, like the preceding set, are rather irregular, and it is difficult to believe that they can represent the variations of stress in a body having any approach to homogeneity.

Before concluding the memoir with some attempts at semi-empirical determination of stresses, the following processes are suggested for dealing practically with any proposed design:—

"(1) Form a glycerin-gelatin white pigmented jelly dam of the given contour. Determine the form and fixing of the substratum to represent as closely as may be feasible the local conditions. Rule the surface.

"(2) Apply water pressure and determine by the methods indicated above, using either a direct or optical micrometrometer, the shear distributions. Ascertain the forms of the horizontal and vertical section shear curves.

"(3) Thence by integration—of course mechanical—find the distribution of normal stress along one or two base sections. From these deduce the stretches and squeezes, and take as definite conditions of stability that the maximum stretch and squeeze shall be less than certain values which may be effectively fixed by experiment."

The authors then say that, with such a test, dams like the Vyrnwy and Assuan are found to be theoretically stable, whereas the mid-third rule gives only an apparent theoretical stability.

We are grateful to the authors for their presentation of the interesting results of such difficult experiments, and hope that their work may bear fruit. Their results must stimulate discussion of a highly important subject; but we imagine that the day is not yet when the civil engineer will proceed to the design of a masonry dam, as the authors suggest, by "forming a glycerin-gelatin white pigmented jelly of the given contour, and determining the form and fixing of the substratum so as to represent as closely as may be feasible the local conditions." Here, it seems to us, there are added to the uncertainties of actual conditions, a set of experimental processes liable to error at many points. He will probably prefer to base a new project on the designs of existing dams, modified as these may be from time to time in the light of new ideas, and perhaps by suggestions coming from work of the character of that under review. E. BROWN.

THE ETHNOLOGY OF AFRICA.

THE communication by Dr. F. C. Shrubbsall—"Notes on some Bushman Crania and Bones from the South African Museum, Cape Town"—issued as part v., vol. v., of "Annals of the South African Museum," in continuation of a paper by the same author in the *Journal of the Royal Anthropological Institute* for 1897, is an important contribution to the ethnology of that region. Incidentally, it marks a reaction against established methods in anthropometry, which, particularly in the case of mixed races, are now treated with well-merited suspicion. In place of an induction founded upon a single "index" derived from the study of the relative magnitude of one skull dimension in terms per cent. of some other dimension, the present paper is based on no less than eighteen factors, and the figures have been subjected to statistical investigation on the most modern lines.

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The inquiry starts from a series, unfortunately limited in numbers, of skulls of the race known as the Strandloppers found in caves along the south-eastern seaboard. These constitute a group more pure than that of the Bushmen, and apparently quite distinct from that of the Hottentots. The up-country Bushmen are intermediate between the Strandloppers and the Hottentots. The latter, again, present dimensions between the up-country Bushmen and the Bantu, and in many characters they approach the Negroes of British Central Africa more closely than the Kafir tribes of the east coast. The Central African Pigmies are by their prognathism clearly removed from the Bushmen, and those of the forest zone seem to be largely mixed with the Negro strain. Thus the purest dwarf race is, or was recently, located on the coast at the extreme south of the continent, the furthest point to which, under pressure, they could retreat.

Eastern and part of south-western Africa are occupied by distinct races of Bantu speech, between whom, in character as well as in position, the Hottentots seem to be intermediate. Quite distinct from these races already mentioned are the Somalis and Gallas, of whose physical character little is known. The Masai further south may be allied to these, but they are quite distinct from the Bantu-speaking Negroes. The West African Bantus, between the Rio del Rey and the Congo, in some respects resemble the eastern tribes of the same stock, in others approximate to the Pigmies.

The race history of South Africa may thus be reconstructed—the first inhabitants were of the Bushman type. Round the great lakes and in the Upper Nile valley the tall Negro tribes were developed, or at least are found in occupation of this region. Pressure from the east drove a large section of these southwards, and these in their turn pressed the Bushmen partly to the extreme southern coast, partly into the forest zone, where they intermingled with their neighbours. Some of the Negroes, again, passed north of the forest tract towards the Atlantic shores, and under pressure of tribes from across the Sahara were in part driven back to the forest, and in part down to the western sea, where in an unsuitable environment their physique deteriorated. Some of these Negroes may have been forced down the Nile valley, taking with them or driving before them any survivors of the northern Bush races, who thus came into contact with Egypt; or, as an alternative, it is not impossible that the range of the Bush peoples may have previously extended much further to the north than is usually supposed.

These conclusions rest, as we have said, on a comparatively small number of skulls. It is to be hoped that a fuller supply of African crania may soon be available by which these interesting speculations may be more adequately tested.

THE PLACE OF THE LABORATORY IN THE TRAINING OF ENGINEERS.¹

IT is now generally conceded that the advancement and prosperity of an engineering establishment depend upon the number of well-trained employees it possesses, but much difference of opinion exists as to whether the education given in our engineering colleges is of the kind best fitted to produce the type of man who will be of real value to his firm.

As a rule, at the present day, a boy who intends to become an engineer, on leaving school takes up a three or four years' course at an engineering college. On leaving college he will be found to have a fair theoretical knowledge of engineering, to be capable of making a drawing, of testing specimens of materials, of taking indicator cards, and, generally, of carrying on an ordinary engine or boiler trial. As a rule, however, he is incapable of making much practical use of his scientific knowledge, and if compelled to act on his own responsibility in the case of some mechanical problem often fails badly. Many employers thus look coldly on a system of education which produces such poor results, and we have here an explanation.

¹ Based upon a paper read before the Institution of Engineers and Shipbuilders in Scotland, by Prof. A. L. Mellanby.

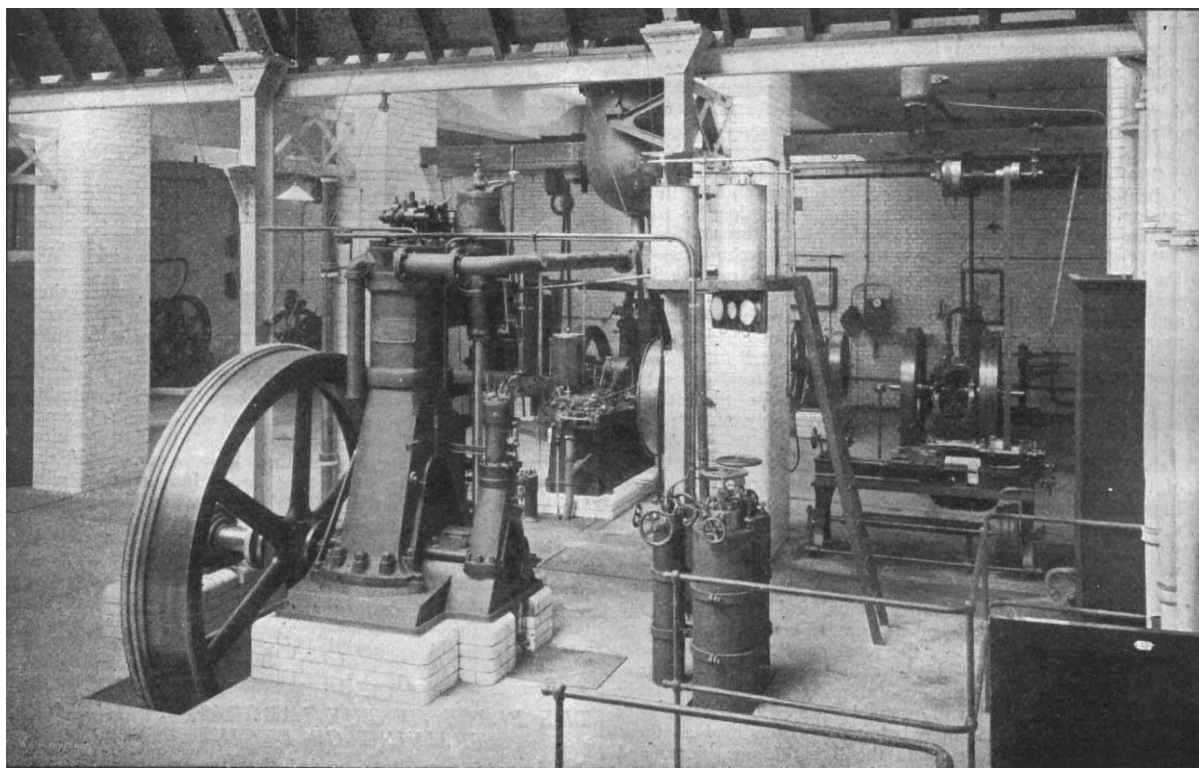
ation why the chief draughtsman and foreman so often state that they would rather have a boy straight from school than one who has undergone a college training.

To one experienced in both the practical and academic departments of engineering, it is evident that the average college training is unsatisfactory. It has grown up because it created least disturbance to the existing state of things, and the development of this system is chiefly the fault of the employers themselves. Anyone who has read the literature dealing with technical instruction must come to the conclusion that the advance in education has been almost entirely due to the students alone. They have seen the necessity for information concerning the principles of engineering, and have in the past attended college courses with no encouragement from outside sources. At the present day this is fortunately changed, and employers are, on the whole, not unwilling to support a system of education which they see is advantageous to themselves.

The author is of the opinion that our college engineering courses would be vastly improved if it were made

three years he would keep up his studies, especially devoting himself to mathematics and physics. At the end of this time he ought to return to college, and take during the winter the second year's course. The following summer would be again spent in the workshops, and the next winter would be devoted to the third course of college work. Before allowing an apprentice to take up his second year's course at college, it must be seen that he can give evidence of having made material progress in his theoretical knowledge during his three years at the works. The method by which the student would continue his scientific education in this period must of necessity depend upon the employer. Attendance at evening classes would produce least disturbance in the works, and there is no doubt that a hard-working student could get a fair amount of knowledge in this manner. The other alternative is that the apprentices be allowed to attend day classes for, say, two afternoons per week—a system already being tried by several firms.

The advantages of such a system are obvious. The



Gas and oil engines. Glasgow and West of Scotland Technical College.

the rule that a considerable amount of workshop practice should precede the final attendance at college. In support of this proposal it may be pointed out that if college training is to produce men who are capable of inventing new processes and improving existing methods of manufacture, then the training must not confine itself altogether to principles, but must direct attention to current engineering work. It therefore follows that the student who wishes to take up his technical studies with profit should not only be prepared with a sufficient knowledge of mathematics and physics, but must also have a working acquaintance with engineering practice. The following plan is suggested as one likely to be the most fruitful.

The student after leaving school should immediately proceed to college, and there take up the first-year general course, whereby he will gain a preliminary grounding in mathematics and science. At the close of the college session he ought to enter an engineering works, where he should remain for at least three years. During these

student would take up his second and third years' college work with such a preliminary practical and theoretical training that the whole character of present-day college classes could be changed. The elementary descriptive lectures, so necessary to schoolboys, could be omitted, and in their place lectures of vital importance to every-day engineering practice could be given, and the most recent developments could be described and discussed. The laboratories, instead of being places for elementary testing, might develop into schools for real research. Practical problems that had arisen during workshop experience might be settled by direct experiment, and an amount of information gathered that would in a short time lead to an immense improvement in our national engineering. It appears to be almost universally believed that inventions are the outcome of sudden inspiration to men of genius, and, like poetic effusions, are independent of environment and experience. Such an idea is far from the truth, for most great discoveries have only been evolved after the

closest research, and then by men who have had a training of such a kind that their critical faculties are strongly developed. It cannot be too strongly impressed upon employers how much more valuable an apprentice would be were he to have an opportunity of continuing his mental training in the laboratories of our well-equipped colleges after having first been impressed with the real problems of his calling by some years in engineering works.

The plan suggested above can only be carried out with the help of the employer. His works may at first suffer some disorganisation, but he must see that this is a national problem, and that plan of training can only be the best which results from cooperation with the engineering colleges, even although such a system involves some personal sacrifice.

There must be something radically wrong with a system of apprentice education which appears to be quickly bringing British engineers to the position of manufacturers, under license, of foreign inventions. It is quite evident that by allowing a student to undergo considerable workshop experience before attending his final college course the trained engineer of moderate ability would be a sounder man, while the clever man would have an opportunity of exploiting his capacity for research work. It must, however, be insisted upon that the proper education of our young engineers depends altogether upon the attitude of the employers towards it. If they do not realise the national significance of such higher scientific training as is here contemplated, it is useless for the heads of our colleges to devote attention to schemes of study capable of promoting it.

In designing the laboratories of the Glasgow and West of Scotland Technical College, provision has been made for the comparatively large number of older students attending the final courses in engineering by putting in a number of machines adapted for research work. The illustration shows one corner of the laboratory devoted to motive-power engineering.

AMERICAN INVESTIGATIONS ON ELECTROLYTIC CONDUCTIVITY.¹

THE two monographs here noticed owe their existence principally to the means placed at the disposal of American workers by the Carnegie Institution of Washington. Without such aid these extensive systematic researches could scarcely have been undertaken, and their publication, unless in abbreviated form, would have presented considerable difficulties.

The report by Prof. Noyes on the work of himself and his collaborators is of the utmost value to all those who are interested in problems connected with the conductivity of aqueous solutions, salt-hydrolysis, and the like. The main object of the research was to obtain accurate values for the electrical conductivity of solutions in a range of temperature from 0° to 300°, and the chief difficulty experienced was in the construction of a conductivity vessel which should be at once capable of resisting the high vapour pressure of solutions up to the critical point of water, and of yielding only traces of conducting impurity to the aqueous solutions it contained. By three years of patient labour Prof. Noyes and Dr. Coolidge succeeded in constructing a platinum-lined bomb with insulated electrodes, which even at high temperatures and with salt-solutions as dilute as 0.0005 normal gives conductivity measurements accurate within 0.2 per cent. With this apparatus the conductivities of typical substances were measured, the results obtained being given and discussed in detail in the report. The substances embraced in the investigation are the chlorides of sodium, potassium, and ammonium, the nitrates of silver and barium, the sulphates of potassium and magnesium, the acetates of sodium and ammonium, the hydroxides of barium, sodium, and ammonium, and, finally, hydrochloric, sulphuric, nitric,

phosphoric, and acetic acids. In order to obtain data for calculating the ionisation constant of water, the conductivities of diketotetrahydrothiazole and its ammonium salt were also measured. The value of this constant as so determined agrees well with that obtained by Kohlrausch from the conductivity of pure water. Two special sections deal with the solubility of silver chloride, bromide, and thiocyanate at 100°, and with the transport numbers of nitric acid. From the last section it appears that the ratio of the velocity of the anions to that of the hydrogen ion is several per cent. larger at very small concentrations than at moderate concentrations, and not constant for all solutions more dilute than 0.05 normal, as is usually assumed.

Prof. Jones, of the Johns Hopkins University, has for a considerable number of years busied himself with the study of solutions, especially from the standpoint of the so-called hydrate theory, which in its present aspect differs greatly from the theory which went under that name some fifteen or twenty years ago. In this communication Prof. Jones and his co-workers give the results of their investigation of the conductivity and viscosity of certain electrolytes in water, methyl alcohol, ethyl alcohol, acetone, and in binary mixtures of these solvents. The connection between the fluidity of a conducting solution and the value of its electric conductivity has long been recognised, but comparatively little detailed experimental work has been done on the subject, so that the present research, which shows the close parallelism between the two properties, not only for aqueous, but for other solutions, is of much interest and value. The problem of the variation of conductivity with change of composition of the solvent is extremely complex, but the authors may be said to have laid a safe foundation for the theoretical treatment of the subject.

THE TUBERCULIN TEST FOR CATTLE.

THE unsatisfactory nature of the tuberculin test for cattle is emphasised in two articles published in the "Live Stock Journal Almanac" for 1908. Mr. Bruce remarks that when an animal reacts there is no indication whether the case is serious or not; that an animal which reacts freely may, when tested a month or two later, fail to do so; that change of place, of companionship, and of diet, the advent of œstrus, or, in fact, anything calculated to excite the animal or upset its digestive system, may render the test abortive.

Mr. Thornton records that testing cows in calf is apt to bring on abortion, and adds that in Germany the test is considered untrustworthy, because of the number of slaughtered animals proved to be tuberculous which have passed the test, and the number in which no tubercle could be found which have been condemned by the test. He concludes, however, with the resignation common among breeders when dealing with such matters:—"The test is naturally upheld by many veterinary surgeons, and there is not much probability of it being discontinued, as members of the profession are generally selected as advisers to the Boards of Agriculture in the colonies and foreign countries," and he might have added in this country also.

With such facts before them, with the knowledge that the disease is not necessarily hereditary, that it is by no means so infectious as has been supposed, and that it is not so largely responsible for the spread of tuberculosis among human beings as we were at one time led to believe, one can hardly blame breeders if they show unwillingness to accept the doubtful blessing of the tuberculin test.

In an article on hybrids, Mr. C. T. Davies complains that the term hybrid is often loosely applied by Mendelians and other experimentalists who have little knowledge of practical breeding, to the offspring of two varieties sprung from the same stock. He points out that "cross-breeds" is the term practical breeders use for such produce, while "hybrid" is used to designate the progeny of two distinct species. He expresses the hope that biologists will adopt the ancient form of nomenclature, and so avoid confusion in the minds of those of their readers who are practical men.

¹ "The Electrical Conductivity of Aqueous Solutions." By Arthur A. Noyes. Pp. vi+322. (Washington: Carnegie Institution, 1907.)

"Conductivity and Viscosity in Mixed Solvents." By Harry C. Jones. Pp. v+235. (Washington: Carnegie Institution, 1907.)